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ABSTRACT

The mission of the National Aeronautics and Space Administration (NASA) is space exploration and research in space and aeronautics for peaceful purposes and for the benefit of all mankind. The organization and programs which have been established to carry out this mission are described. Full color illustrations for the book were selected from the NASA Fine Art Program. (Author/PR)

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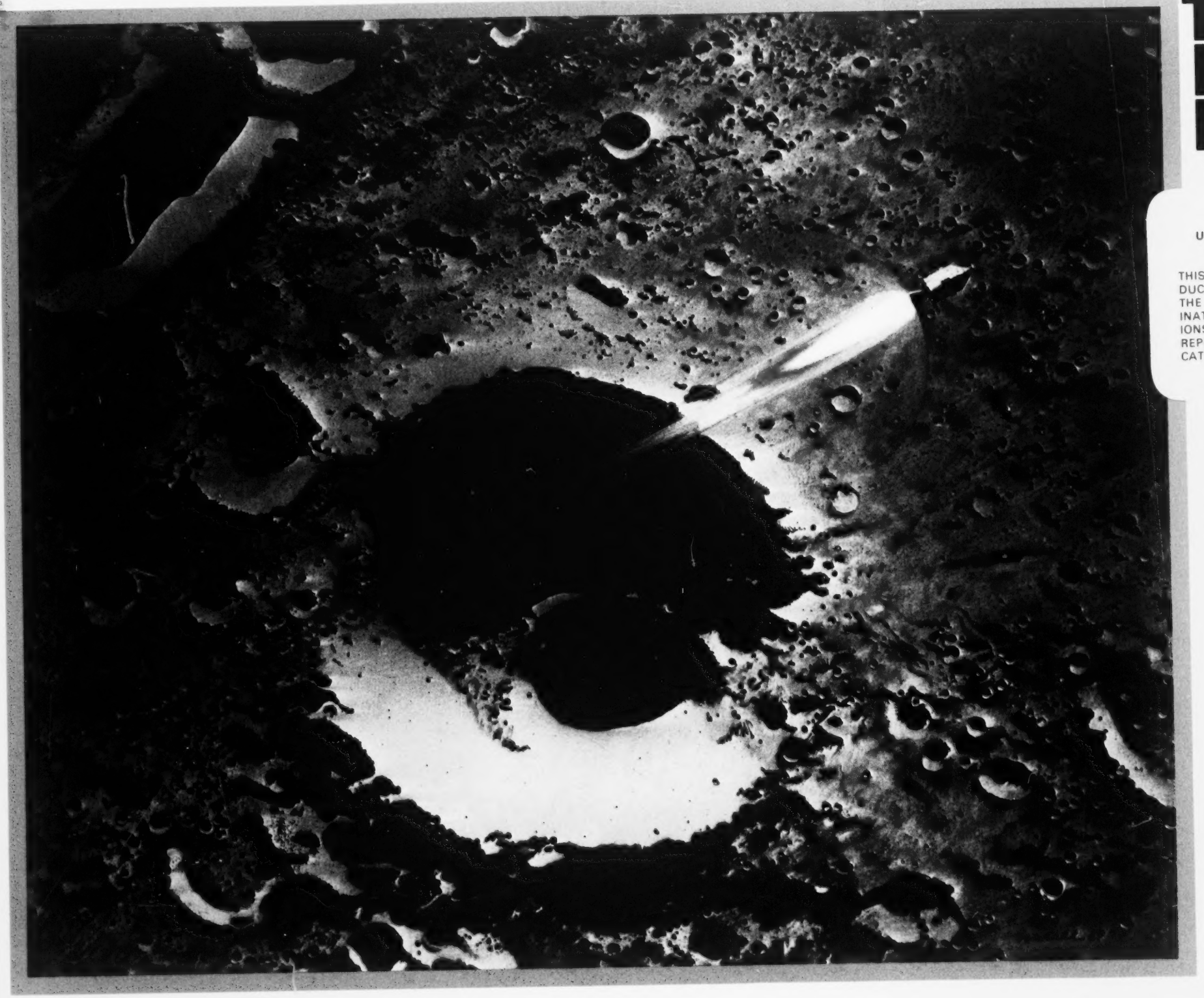

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JUNE 1971

Cover: APOLLO 8 COMING HOME, oil on panel, by Robert McCall. The Apollo 8 spacecraft fires its engine to propel it out of lunar orbit and start the return trip to Earth.

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This Is NASA. Giant rockets lifting from their launch pads and speeding into the vastness of space . . . Computers plotting trajectories, fuel consumption, orbits and reentry times and places . . . Technicians at consoles following the progress of launch vehicles and spacecraft . . . Man walking on the Moon.

This is NASA, in terms of the sights and sounds of space flight.

Behind the drama are functions, organization and people. Research and development programs expand human knowledge of phenomena in the atmosphere and space. And NASA is charged with carrying out the stated policy of the United States that "activities in space should be devoted to peaceful purposes for the benefit of all mankind."

The space program benefits man in many ways: new knowledge, improved weather forecasting, better global communications, and new products, processes, and techniques applicable to industry, medicine, and education among others. Moreover, it has developed management systems that can be applied to mobilize vast resources of people and materials effectively in any new programs government or industry may undertake.

NASA began with enactment of Public Law 85-568, the National Aeronautics and Space Act of 1958, approved July 29, 1958, and authorizing establishment of the National Aeronautics and Space Administration.

The agency took tangible form on October 1, 1958, with assignment to it of the 43-year-old National Advisory Committee for Aeronautics. This venerable organization, headquartered in the historic Dolley Madison House, Washington, D. C., directed five field laboratories: Ames Aeronautical Laboratory (now Ames Research Center), Mountain View, California; High-Speed Flight Station (now Flight Research Center) at Edwards, California; Langley Aeronautical Laboratory (now Langley Research Center), Hampton, Virginia; Lewis Flight Propulsion Laboratory (now Lewis Research Center), Cleveland, Ohio; and the Pilotless Aircraft Research Center (now Wallops Station), Wallops Island, Virginia.

To this nucleus were added other responsibilities. The Naval Research Laboratory's Project Vanguard was shifted to NASA, as was the Army's Jet Propulsion Laboratory contract operation managed by the California Institute of Technology, and the Development Operations Division of the Army Ballistic Missile Agency at Huntsville, Alabama. The latter developed into the George C. Marshall Space Fight Center. Transferred from the ABMA with Development Operations Division was a part of ABMA at Cape Canaveral, Florida, that was set up as the Launch Operations Directorate of the Marshall Center. Later, this grew into the John F. Kennedy Space Center, Kennedy Space Center, Florida.

NASA established other major facilities: Goddard Space Flight Center, Greenbelt, Maryland; Manned Spacecraft Center, Houston, Texas; KSC Western Test Range Operations Division, Lompoc, California; and jointly with the Atomic Energy Commission, the Space Nuclear Systems Office, Washington, D. C., and its field installation, the Nuclear Rocket Development Station, Jackass Flats, Nevada.

Facilities set up during peak years of space activities but now reassigned or with reduced use in the space program include: Electronics Research Center, Cambridge, Massachusetts (now part of the Department of Transportation); Mississippi Test Facility, Bay Saint Louis, Mississippi; and Michoud Assembly Facility, New Orleans, Louisiana.

NASA today is a future-oriented organization of about thirty thousand employees acting in concert with industry, universities, and other Government agencies on a variety of projects in aerospace science and technology, including aeronautical research.

Manned Space Flight. On July 20, 1969, Apollo 11 Commander Neil A. Armstrong set foot on the Moon, climaxing a series of manned space flights that began with the Mercury suborbital flight of May 5, 1961. Project Mercury was organized on October 5, 1958, to orbit a manned spacecraft, investigate man's reactions to and abilities in space flight, and recover both man and spacecraft.

Project Gemini, with two-man crews and longer Earth-orbital flights, extended the technology and experience gained in Project Mercury and paved the way for lunar landings in the Apollo program.

While Apollo manned missions continue to expand man's knowledge of the Moon, NASA will proceed with the Skylab program to establish the Nation's first manned Earth-orbiting space station. Skylab itself will consist of a modified third stage of the Saturn V launch vehicle that is used for Apollo missions to the Moon.

The first Skylab three-man crew will stay in space for 28 days; the next, for 56 days. Principal purposes will be to study the health and physical fitness of the crew and habitability of living and working quarters; conduct experiments in Earth resources observation, meteorology, materials processing, and other advanced science and technology; and study the Sun with telescopes.

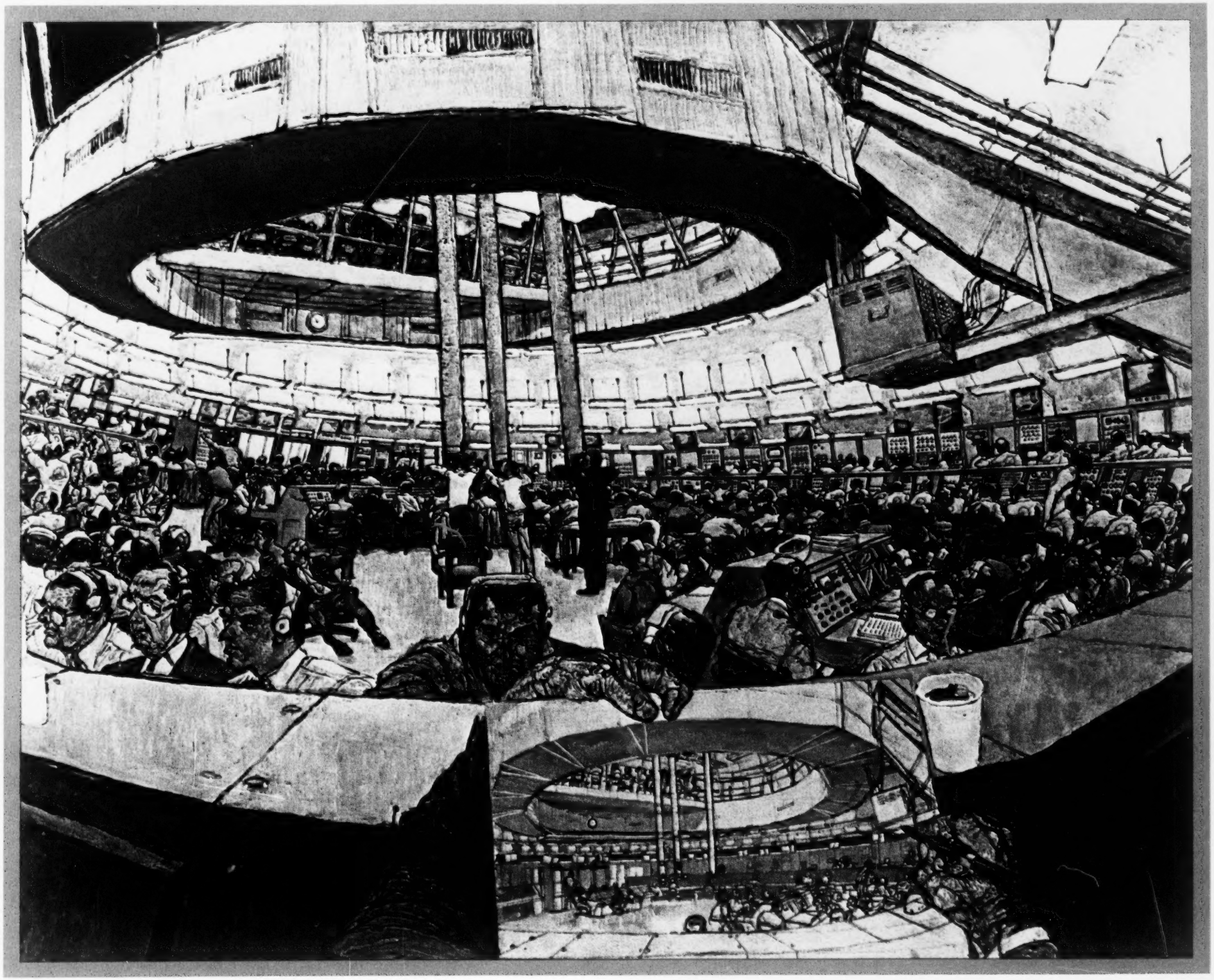
Skylab is seen as the forerunner of larger and more advanced space stations and of manned interplanetary spacecraft. The space station following Skylab may be a 6 to 12 man modular structure that could remain in orbit for as long as ten years. Its parts, or modules, would be flown into orbit individually and assembled there.

Astronauts would commute between the space station and Earth in a reusable space shuttle. Now under development, the shuttle is envisioned as consisting of an airplane-like booster and orbiter which are separated after launch. Following the separation, the booster would return to Earth while the other part continues into orbit. Both the booster and orbiter would land on Earth like airplanes.

Uses of the space shuttle may include: placing unmanned satellites into Earth orbit, delivering supplies and propellants to orbiting spacecraft, repairing satellites or returning them to Earth for repair, and launching unmanned interplanetary spacecraft into Earth parking orbit, from which a rocket attached to the spacecraft would fire it beyond Earth orbit.

Also being considered is a space tug. The principal uses of the tug would be to assemble manned space stations and manned interplanetary craft with its remote-controlled manipulating arms. It would have sufficient power to change orbit and to hurtle interplanetary spacecraft out of orbit toward their planetary destinations. Another possible use of the tug is to land men on the Moon for long term exploration.

SATURN BLOCKHOUSE, acrylic on canvas, by Fred Freeman. Inside the Saturn I-B blockhouse, technicians monitor the final minutes of a countdown.



Weather Watchers. An operational meteorological satellite system developed from NASA's Tiros and Nimbus experiments provides pictures of cloud cover over the globe both day and night for the National Oceanic and Atmospheric Administration (NOAA). The system has contributed significantly to accuracy of one and two-day weather forecasts and increased man's ability to discover and track hurricanes, thus helping to save lives and property. Sea ice charts are prepared from weather satellite pictures. Airplane and ship navigators use photographs taken by weather satellites to chart courses that avoid destructive storms.

NASA's Nimbus program conducts research in satellite meteorological technology. Advances derived from NASA research and development are incorporated as soon as possible into the National Operational Meteorological Satellite System of NOAA.

NASA's versatile Applications Technology Satellite (ATS) conducts experiments in meteorology, navigation, and communications satellite technologies.

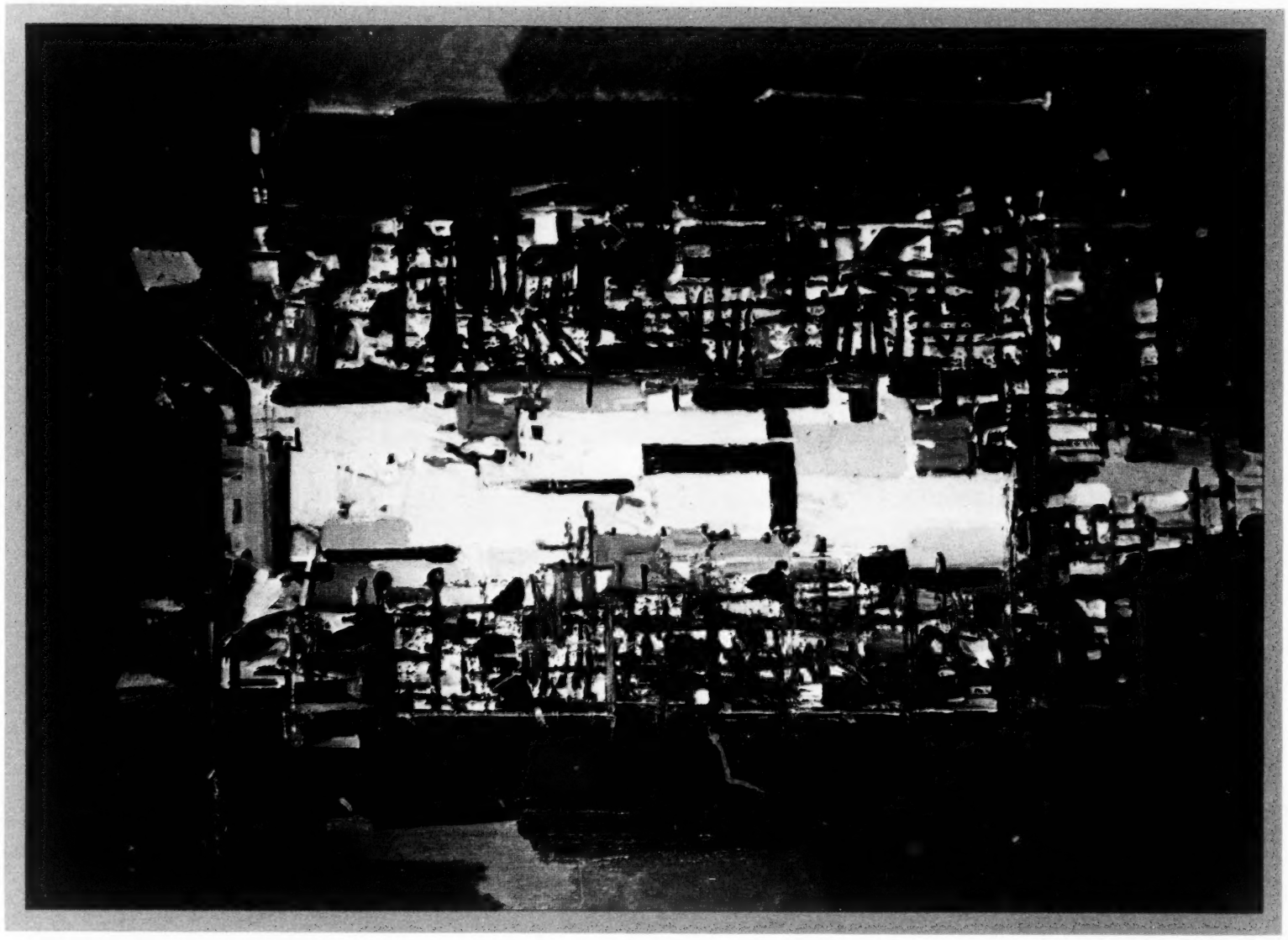
ATS is placed in a circular orbit about 22,300 miles above the Earth's equator. This is a "synchronous" orbit—the spacecraft takes as long for an orbit as it takes the Earth to rotate on its axis and the satellite appears to stand still relative to a point on the Earth's surface.

From this station one ATS can take useable photographs of weather over nearly 25 percent of the Earth. Because it is stationary relative to Earth's surface, ATS enables weathermen to watch weather patterns almost continuously for forecasting, for specific observation of the birth and development of violent storms, such as tornadoes, and for generalized study.

The technology and experience gained in the ATS program have contributed significantly to the planned operational Synchronous Meteorological Satellite (SMS) system. After checking out each future SMS in orbit, NASA will turn it over to the NOAA for operational use.

Study and application of data from weather satellites can help obtain the long sought goal of two-week weather forecasts. Potential benefits from such long range weather forecasts are enormous. Crops and property could be protected against damaging weather; construction, shipping, and airlines would also profit significantly; public utilities could be better managed because of advance knowledge of load requirements.

NIGHT BEFORE LAUNCH, oil, by Lamar Dodd. Launch preparations for a Saturn/Apollo continue through the night before a flight.



Orbiting Radio Relays. The NASA Echo, Relay, and Syncom projects and the AT&T Telstar program established the principal technologies that led to the present global commercial communications satellite system. The Communications Satellite Corporation (COMSAT) operates the system on behalf of the 74-nation International Satellite Consortium (INTELSAT).

The system has made world-wide live color telecasts possible and helped meet the mushrooming demands for overseas telephone circuits. During the past five years, the number of overseas calls has grown about 25 percent annually. In September 1970, American Telephone and Telegraph Company reported a 43 percent year-to-year increase in telephone calls between the United States and Europe.

NASA's Applications Technology Satellite (ATS) program helps develop satellite technology to meet new comunications requirements. Among possible new communications demands of tomorrow are facilities for educational television to speed progress of peoples in developing nations, rapid worldwide exchanges of medical information, and, perhaps, facsimile transmission of mail.

ATS also is used for meteorological studies (page 4) and for navigation and traffic control experiments. A National Academy of Sciences study of traffic control and navigation over oceans concluded that satellite systems offer the best means of handling traffic on the crowded air and sea lanes expected in coming decades. The Academy further said that even today present systems frequently cannot handle transoceanic air and sea traffic control without costly diversions.

Air traffic control and navigations systems now require transatlantic airliners to stay about 120 miles apart laterally, 15 minutes ahead or behind each other, and about 2000 feet above or below other aircraft.

If satellite air traffic control and navigation systems make it possible to operate safely with reduced separations between aircraft, the savings in time and related expense will be substantial.

APOLLO 11 SUIT-UP, ink on paper, by Paul Calle. Apollo 11 astronauts Armstrong, Aldrin and Collins don their spacesuits on the morning of their flight to the Moon.

New Views of the Earth. Satellites have already given us new views of our planet and its near space environment. They have indicated that the Earth tends to be pear-shaped and bumpy with a bulging midriff. (These irregularities are minute in comparison with the Earth's diameter and circumference, but accurate measurements of them are very important to scientists.) The satellites have verified the extent of the intense Van Allen Radiation Region over Earth. They have revealed that Earth's magnetic field looks like an elongated tear drop stretching at least three and one-half million miles outward on the Earth's night side. They have reported on atmospheric particles, tiny meteoroids, and other phenomena in space near Earth.

For the future, an Earth resources satellite program is proposed to gather data on natural resources. Discoveries of untapped mineral wealth and fresh water, information for utilization of land for farming and forestry, assistance in telling man when and where to fish, measuring the magnitude of air and water pollution, and aid for urban planning by surveying the growth of population centers are among the results expected from the program. Potential uses are anticipated in geography, geology, oceanography, hydrology, agriculture, forestry, and cartography.

The planned Earth Resources Technology Satellites will help develop and advance the technology and equipment needed for Earth resources surveys from space. These satellites will provide information regularly and inexpensively after initial launch. They will make repeated observations that show slow changes, will acquire data regularly from areas where other means would be difficult and expensive, and will reveal large scale features that might be overlooked when viewed at lower altitudes.

POINTS OF PERSPECTIVE, egg tempera, by Robert Vickrey. A workman checks the inclined surface of the launch pad for damage after the launch of Apollo 12.

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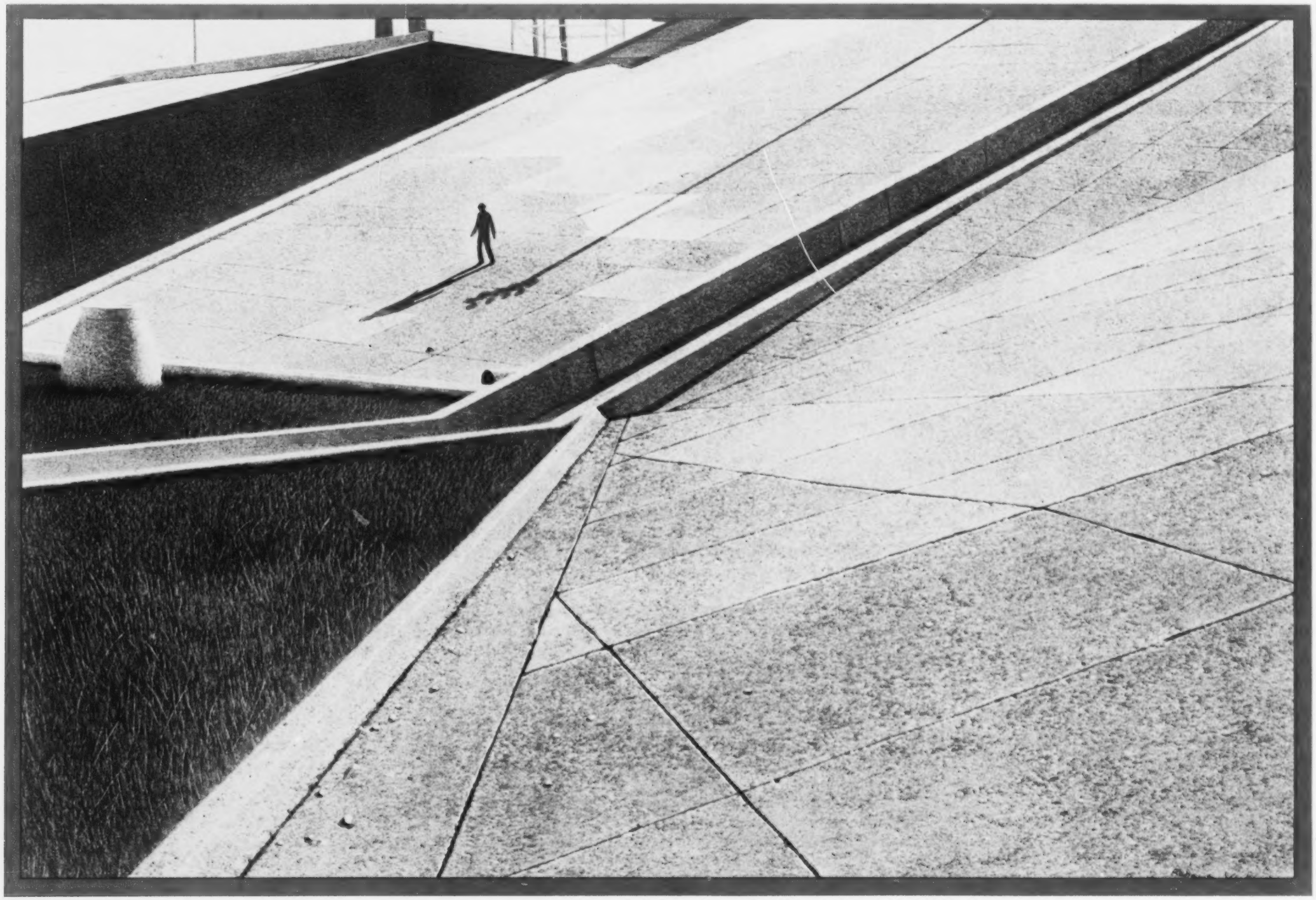

Fig. 12

Beyond Earth. Orbiting Solar Observatories study changes on the surface of the Sun during the 11-year solar cycle, as the Sun's activity drops from a maximum to a minimum and then rises again to a peak. Orbiting Astronomical Observatories gather scientific data about stars and galaxies. Both observatories have given astronomers an opportunity to study the Sun and the Universe from a position above the murky haze of our atmosphere. The atmosphere cuts off many types of radiation from space important to understanding the nature, origin, and evolution of stars, galaxies, and other phenomena.

Automated spacecraft preceded the Apollo astronauts who stepped on the lifeless crystalline dust of the Moon. Now, such spacecraft are blazing trails to other planets.

Mariner spacecraft have already reported on the cratered face of Mars and the wierdly dense atmosphere and intense surface heat of Venus. They and Pioneers have explored interplanetary space out to approximately the orbit of Mars.

Mariner observations of Mars were made during relatively fleeting periods as the spacecraft sped by the planet. NASA now plans to place Mariner in orbit around Mars to gather information over different areas. Still later, NASA will send Viking toward Mars.

A section of Viking will land on the Red Planet to search for signs of life and gather other surface data. The other section will make its observations from Martian orbit. Its observations will be correlated where appropriate with those of the lander.

Another Mariner is scheduled to be launched on a trajectory that will enable it to sweep near Venus and Mercury. As it reaches the Venusian vicinity and reports its observations to Earth, Venusian gravity will deflect and accelerate the craft toward Mercury. As Mariner sweeps by Mercury, it will provide man with his first nearby observations of that mysterious planet.

NASA's Pioneers will open the exploration of the outer solar system. Pioneers will be launched to fly by and report on Jupiter. Jupiter's gravity is expected to hurl them into trajectories never before achieved by spacecraft.

In the late 1970's, automated spacecraft will be launched on Grand Tours made possible by a rare alignment of the outer planets (Jupiter, Saturn, Uranus, Neptune, and Pluto). This alignment, which will not be repeated for about 170 years, enables a spacecraft to employ the gravitational force of one planet as an aid in hurtling toward the next. With this technique, the time for flight from Earth to the other planets can be substantially reduced. For example, a spacecraft can reach Pluto in about nine years as compared to more than forty years required for a direct flight from Earth. The tours will enable man to obtain closer looks at the outer planets than ever before possible.

ONE—TWO—THREE, watercolor, by James Wyeth. Astronaut rescue vehicles are positioned near the Apollo launch pad. They are used only in the event of a serious emergency during the last minutes of a countdown.

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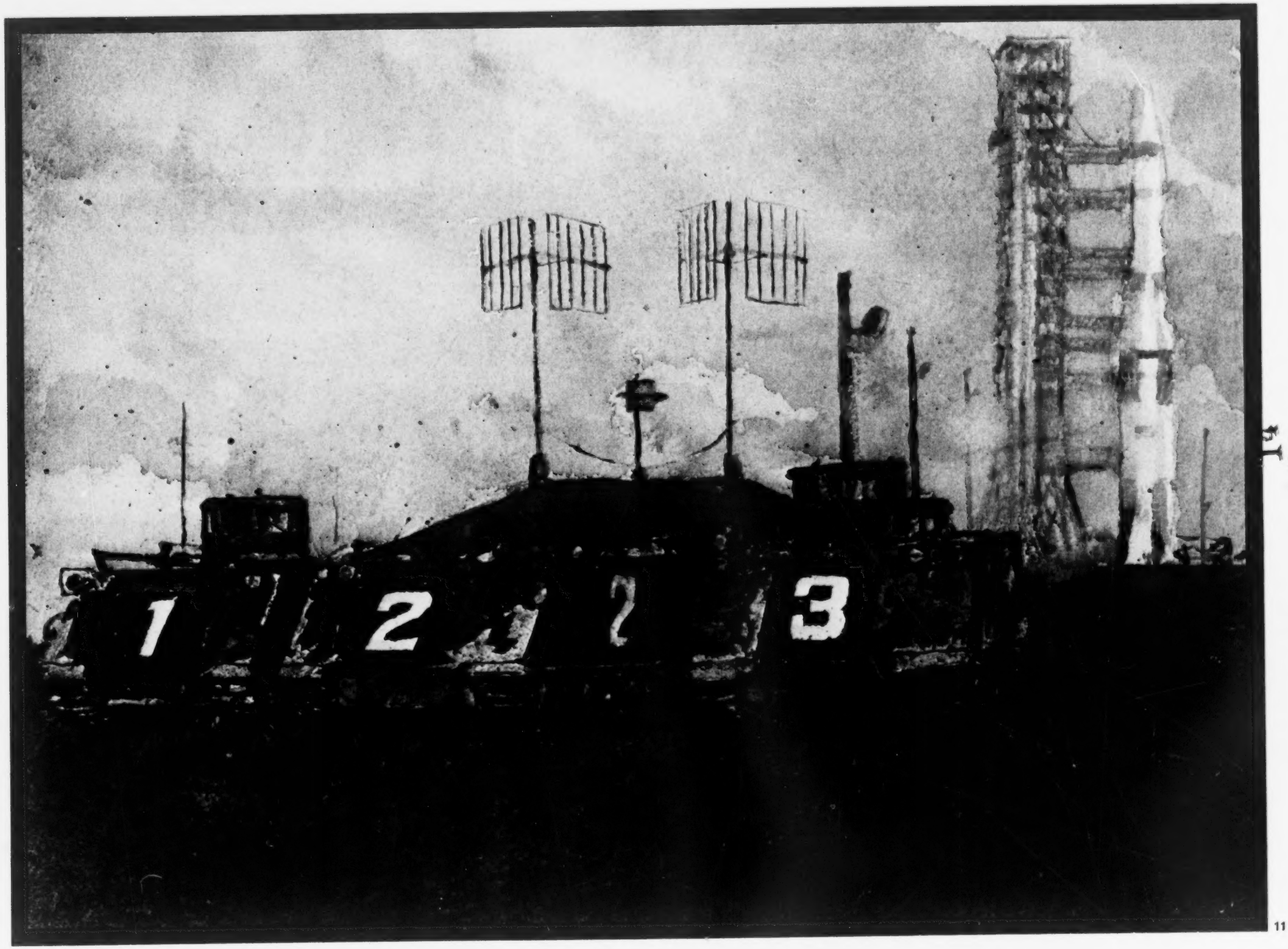

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Looking Ahead in Air Transportation. NASA's role in aeronautics consists of research to help solve today's problems and meet tomorrow's needs. NASA research has contributed to progress in such areas as testing of military and commercial subsonic, supersonic and vertical and short take-off landing craft; advanced materials, electronics, and structures; improving cockpit instrument displays; collision-avoidance systems, and hydroplaning on wet runways.

NASA originated the supercritical wing concept which has the potential for substantially improving the performance of subsonic commercial airliners.

NASA's work on jet engine noise, in which acoustic panels and adjustable air inlets are used to curtail sound, has demonstrated that major reductions in noise levels are possible without jeopardizing engine performance. For the future, work is under way to produce even quieter engines.

Advanced Research—Steppingstone to Tomorrow. Advanced research looks toward the future of both space and aeronautics. Among the space flight projects are design and development of efficient practicable nuclear and electric rockets; long lasting and lightweight on-board sources of electric power generation; advanced communications; life-support systems that can operate indefinitely; and better integration of men and machines. Work continues on foods for space flight, pressure suits, life-support atmospheres, radiation resistance, meteoroid shields, biomedical reactions of man to space flight, lunar shelters, and hundreds of other projects. Numerous tasks apply NASA's research capabilities directly to trying to solve the problems of air and water pollution.

THE POWER TO GO, oil on panel, by Paul Calle. The five engines of the Saturn 5 launch vehicle produce 7.5 million pounds of thrust.

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International Programs. NASA conducts a broad program of international cooperation in space and aeronautics. Scientists of more than seventy countries and jurisdictions have participated with NASA in joint satellite and sounding rocket projects, ground-based support such as tracking and data acquisition from spacecraft, and programs of tecnnical training and visitor exchange.

More than twenty satellite projects with a half dozen nations and the European Space Research Organization (ESRO) were in progress or completed by September 1970. In these projects, the United States provides the launch vehicles and other support for foreign satellites. In addition, seventeen experiments of five nations have been flown aboard NASA spacecraft.

NASA's international programs take many other forms. Among them:

• Nineteen countries have engaged in more than five hundred cooperative sounding rocket launchings.

• Forty-five principal investigators from sixteen countries are analyzing lunar samples brought to Earth by Apollo astronauts.

• A planned use of the Applications Technology Satellite is to relay instructional TV from a ground station of the government of India to low cost receivers in some five thousand remote Indian villages.

• About sixty countries are getting better weather forecasts by acquiring information from United States meteorological satellites through use of an automatic picture transmission (APT) system developed by NASA.

• Cooperative aeronautics projects with British, Canadian, French, and German agencies are contributing significantly to improving V/STOL aircraft.

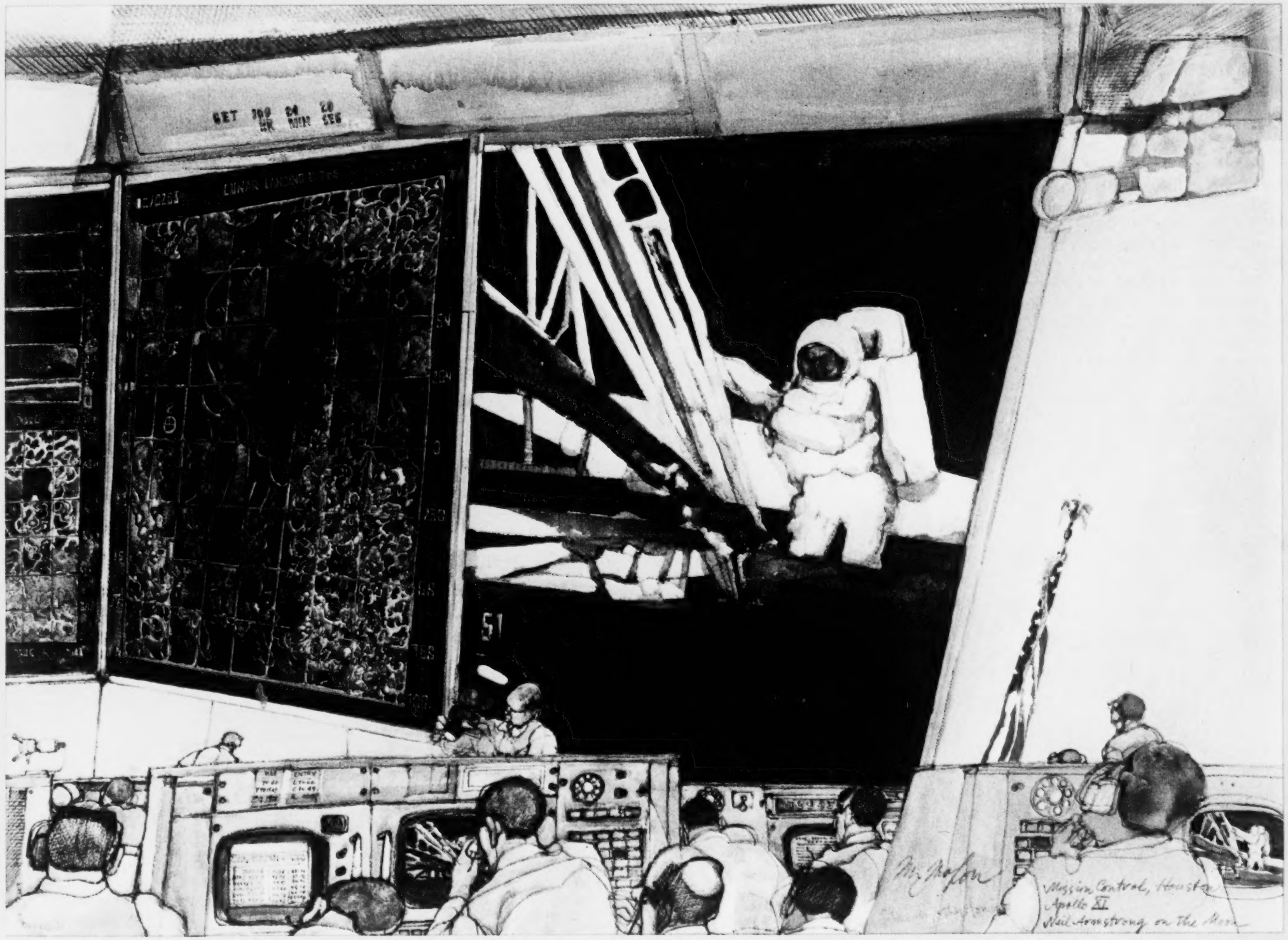
• Policy makers and scientists abroad are being acquainted with the potential benefits of Earth resources survey by satellite and trained to interpret data from such satellites.

Education for The Space Age. NASA educational programs reach hundreds of thousands of students each year. Carefully trained former teachers and supervisors conduct lecture-demonstrations at school assemblies and classroom discussions.

More than twenty-five thousand teachers participate yearly in courses, workshops, institutes, and conferences conducted by universities and colleges, professional associations, and local and county school districts in conjunction with NASA. NASA is also conducting programs in space science education to motivate learning in many subjects, to encourage the scientific interests of highly talented youths, and to stimulate the culturally deprived and those who are not reaching their full potential.

To bridge the gap between information available in standard texts and the rapidly expanding knowledge to which NASA is contributing, NASA has produced a variety of publications and films. Among these are curriculum supplements that relate space to such subjects as biology, chemistry, industrial arts, physics, and mathematics; and booklets, fact sheets, films, and tape recordings to provide general information about specific aspects of the space program.

NEIL ARMSTRONG ON THE MOON, watercolor, by Franklin McMahon. Apollo 11 astronaut Neil Armstrong is seen on Mission Control's television screen as he steps on to the surface of the Moon, July 20, 1969, 10:56pm, EDT.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51
Mission Control, Houston
Apollo XI
Neil Armstrong on the Moon

Adapting Space Technology to Earthly Uses. Space-developed innovations do many things on Earth. A few are briefly described: • Ultraviolet photo tubes, invented for spacecraft, are used as flame detectors in fire alarm systems.

• Techniques and systems for computerized enhancement of telecasts from spacecraft millions of miles away are now applied to human X-rays. One result is that the enhanced X-rays can reveal what were once the most obscure areas of the body.

• Research in effects of space radiation on body cells indicated intercellular linkages that may help to explain certain types of cancer.

• Systems used to monitor the health of astronauts and spacecraft on distant flights are being adapted so that nurses at a single hospital center can watch the conditions of critically ill patients in numerous rooms.

• Stress devices for measuring rocket thrust show internal stresses in dams and warn of any critical structural weakening. Such weakening may follow Earth tremors.

• Research to reduce fire hazards in Apollo spacecraft has yielded materials highly resistant to fire that offer great promise in commercial and residential fire prevention.

• The space program has been a significant contributor to the advancement of computer technology.

Hundreds of companies, large and small, use NASA data dissemination centers at six universities. The centers are designed to help industry apply technical advances made during research on space projects.

Companies are alerted to technological developments by NASA's TECH BRIEFS that describe promising innovations. Sometimes, a single innovation can become an important part of an industrial process or an industry in itself. An example is a cutter-stripper developed by NASA for coaxial cable. It easily and simply does a job previously done laboriously by hand. A company picked up the item from a TECH BRIEF, produced and marketed it, and reported brisk sales.

Among the many other steps taken to facilitate the application of space developed instruments, mechanisms, systems, and other innovations to benefit mankind are the NASA's establishment of Biomedical and Technology Application Teams. The Biomedical Application Teams were organized in 1967.

In 1969, NASA organized Technology Applications Teams. Upon request, the teams assist in identifying and applying technology derived from aerospace research and development to solve problems of national concern, such as air and water pollution, highway safety, law enforcement, urban construction, mass transportation, and mine safety.

GOLDSTONE, watercolor, by Nicholas Solovioff. The Goldstone 85-foot antenna in the California desert is used for tracking spacecraft far out in space.

Principal NASA Facilities.

NASA Headquarters
Washington, D. C.
NASA Headquarters formulates policy and coordinates the activities of the space flight centers, research centers, and other installations which comprise the National Aeronautics and Space Administration.

Ames Research Center,
Moffett Field, California
The work of the Ames Research Center is concerned with laboratory and flight research in space missions and in aeronautics. The fields of space interest include atmosphere entry research, fundamental physics, materials, guidance and control, chemistry and life sciences. Ames aeronautical research includes the areas of supersonic flight, V/STOL aircraft and operational problems. The space flight projects involve management of scientific probes and satellites, and payloads for flight experiments. Project Pioneer is managed by Ames.

Flight Research Center,
Edwards, California
The Flight Research Center is concerned with manned flight within and outside the atmosphere, including low-speed, supersonic, hypersonic and reentry flight, and aircraft operations and safety problems. Space vehicle programs are typified by studies such as flight behavior of lifting bodies. In biotechnology, man-machine integration problems are studied.

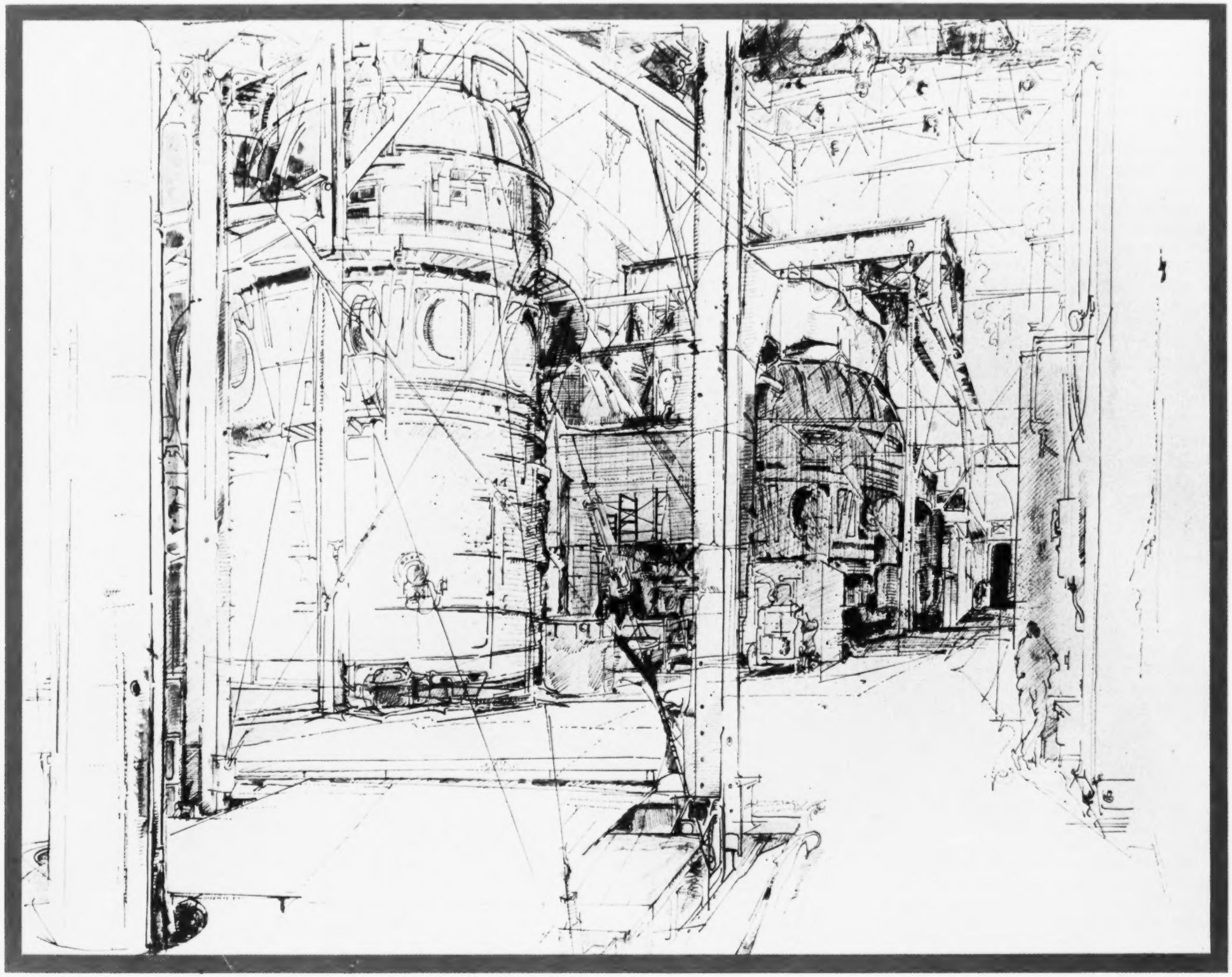
Goddard Space Flight Center,
Greenbelt, Maryland
The Goddard Space Flight Center, named for the rocket pioneer, Dr. Robert H. Goddard, is responsible for the development and management of a broad variety of unmanned Earth-orbiting satellite and sounding rockets projects. Among its major projects are Orbiting Observatories, Explorers, Nimbus, and Earth Resources Technology Satellites. Goddard is also the nerve center for the worldwide tracking and communications network for both manned and unmanned satellites.

Jet Propulsion Laboratory
Pasadena, California
The Jet Propulsion Laboratory is a research, development, and flight center operated for the National Aeronautics and Space Administration by the California Institute of Technology. The Laboratory's primary role is the investigation of the planets using automated scientific spacecraft. Jet Propulsion Laboratory is also responsible to NASA for supporting research and advanced development related to flight projects and the design and operation of the Deep Space Network, which tracks, communicates with, and commands spacecraft on lunar, interplanetary, and planetary missions.

John F. Kennedy Space Center,
Kennedy Space Center, Florida
The Nation's first spaceport, the John F. Kennedy Space Center, makes preflight tests, prepares, and launches manned and unmanned space vehicles for NASA. Manned Apollo missions, unmanned planetary, and interplanetary missions, and scientific meteorological, and communications satellites are launched by Kennedy Space Center. Some launches are from the Pacific Coast; these are conducted by the KSC Western Test Range Operations Division at Lompoc, California.

Langley Research Center,
Hampton, Virginia
Oldest of the NASA Centers, Langley has the task of providing technology for manned and unmanned exploration of space and for improvement and extension of performance, utility and safety of aircraft. The major technical areas of Langley are theoretical and experimental dynamics of flight through the entire speed range, flight mechanics, materials and structures, space mechanics, instrumentation, solid rocket technology, and advanced hypersonic engine research. The Center conceives, develops and operates simulators for aircraft and for lunar landing projects, and conducts V/STOL flight research. The Center is charged with overall project management for Viking.

TEST CHAMBER, ink on paper, by Alfred McAdams. Scientific satellites are carefully checked in these Goddard Space Flight Center test chambers before shipment to the launch site.



Lewis Research Center,
Cleveland, Ohio

The major missions of Lewis are aircraft and rocket propulsion and space power generation. Other fields of investigation are materials and metallurgy, problems concerned with the use of extremely high and low temperature materials. The Center is active in combustion and direct energy conversion; chemical, nuclear and electric rocket propulsion systems; advanced turbojet power plants; fuels and lubricants; and plasmas and magnetohydrodynamics. Lewis has technical management of such rocket stages as the Agena and Centaur.

Plum Brook Station at Sandusky, Ohio, with facilities for propulsion research and development, including a nuclear reactor, is operated as an arm of Lewis.

Manned Spacecraft Center,
Houston, Texas

The Manned Spacecraft Center has the responsibility for the design, development, and testing of manned spacecraft and associated systems; the selection and training of astronauts; and operation of manned space flights. Mission Control for manned space flights is at the Manned Spacecraft Center.

George C. Marshall Space Flight Center,
Marshall Space Flight Center, Alabama

Launch vehicles essential to Apollo and other major missions are designed and developed by the scientists and engineers of the George C. Marshall Space Flight Center. The Center is concerned with launch vehicles of the Saturn class, as well as payloads, related research and studies of advanced space transportation systems. It manages the Skylab project.

Nuclear Rocket Development Station,
Jackass Flats, Nevada

This facility, located near Las Vegas, Nevada, is managed by the Space Nuclear Systems Office, a joint operation of NASA and the Atomic Energy Commission. It contains the test stands and equipment for development of reactor technology and the nuclear rocket. The Station is the scene of many tests of reactors and experimental rocket engines.

Wallops Station,
Wallops Island, Virginia

Wallops Station, located on Virginia's eastern shore, is one of the oldest and busiest ranges in the world. Some 300 experiments are sent aloft each year on vehicles which vary in size from small meteorological rockets to the four-stage Scout with orbital capability. The launches increase knowledge of the upper atmosphere and the space environment.

A sizeable portion of Wallops' effort is devoted to aeronautical research and development and in exporting this Nation's space technology to the international community. Wallops' geographical location makes it a valuable center for aircraft sensing of the Earth's environment.

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